MEMORANDUM FOR: Clifton S. Middleton
Project Director, Survey Section B

FROM: Charles W. Challstrom
Director, National Geodetic Survey

SUBJECT: INSTRUCTIONS: NEBRASKA FBN, 2000 (GPS-1481)
Task Number: 8K6D2000 (FBN)

GENERAL:

The National Geodetic Survey (NGS), in accordance with the NGS Strategic Plan, is engaging in a campaign of observing stations of the Federal Base Network (FBN) to complete the ellipsoidal and orthometric height components of the FBN. This survey will observe the 33 FBN stations in Nebraska.

Mr. Jerry Odum, Nebraska State Geodetic Advisor, has reconned the FBN stations, and they are all suitable for GPS occupation.

Station U 126 (PID NN0248) has been included in the project to serve as a bench mark tie only.

Also, stations E 27 (PID LJ0136), N 121 (PID NN0218), and U 58 (PID NP0422) have been added to the project in order to check ellipsoid heights versus leveling. The stations are to be observed to FBN specifications.

A full-wavelength, dual-frequency Global Positioning System (GPS) receiver is needed to act as Central Temporary Continuously Operating Reference Stations (CTCORS) throughout the project. The receiver shall be deployed at relatively secure stations within the vicinity of the ongoing observing sessions. The receiver shall continuously collect data at a 30-second epoch collection interval for a minimum of 72 hours and for as long as observations are ongoing in the vicinity of the CTCORS.

Approximately 80 Cooperative Base Network (CBN) stations may be co-observed by five different organizations. The CBN coordinator is Mr. Jerry Odum. The project will be performed under the technical management of NGS.

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PURPOSE:

In order to meet America's accelerating positioning and navigation needs, the existing coordinate reference system must be continually enhanced to provide the accessibility and high accuracy required for use with GPS. The digital revolution in mapping, charting, and surveying requires a National Spatial Reference System (NSRS) consisting of, among other components, a network of monumented points having four-dimensional positions. The FBN fulfills the requirements for this component. NGS is charged with the Federal responsibility for establishment, observation, monitoring, and maintenance of the FBN. The FBN provides the critical network foundation for an accurate, consistent, reliable NSRS.

The NSRS, in turn, provides the common geographic framework for America's spatial data infrastructure. As such, the NSRS serves as the basis for mapping, charting, navigation, boundary determination, property delineation, infrastructure development, resource evaluation surveys, and scientific applications, including crustal motion monitoring, modeling of flooding, storm surge, pollution trajectories, and agricultural runoff. A modernized, accurate, consistent, reliable NSRS is of enormous benefit to state, county, tribal, local, and Federal authorities, as well as to the private sector.

SPECIFICATIONS:

Project requirements for the FBN observations are to ensure 2-centimeter local accuracy in the horizontal component, as well as 2-centimeter local accuracy for the ellipsoid heights.

Data from the CORS in the region are to be used in the processing. There are seven NGS CORS in the area to be selected from. Five are in Nebraska, and one each is in Iowa and Colorado. Also, there are three state base stations that are to be incorporated into the project as well.

The five NGS CORS in Nebraska are Whitney (WHN1), Merriman (MRRN), Neligh (NLGN), McCook (RWDN), and Fairbury (FBYN). The CORS in Iowa is Omaha (OMH1). The CORS in Colorado is Platteville (PLTC).

The three Nebraska base stations are located in Grand Island, Gering, and Lincoln. (The base station in Lincoln may not be ready prior to the beginning of the project.)

Positions and data for the NGS CORS are available from the NGS web site. To obtain data for the three Nebraska base stations, contact Mr. Steve Cobb, Nebraska State Surveyor's Office (listed under LIAISON.)

General specifications for the project are as follows. At each FBN and CBN site, three sessions of 5 1/2 hours duration for each session shall be observed. The observing scheme shall be arranged so that for each station, the start time of one of the observing sessions shall be at least 4 hours different from the other two. The observing scheme shall be arranged to ensure that adjacent FBN and adjacent CBN stations are directly connected in at least one observing session, and at least half of all base lines are repeated.

In general, station occupation and observing procedures must be carried out according to appropriate sections of the "NGS Operations Handbook" and the current applicable receiver field manuals. Data formats and digital file definitions are given in "Input Formats and Specifications of the National Geodetic Survey Data Base," Volume I. Horizontal Control Data, Federal Geodetic Control Subcommittee, September 1994, revised and reprinted November 1998. Success in meeting the accuracy standards will be based on repeatability of measurements and adjustment residuals.

General specifications for the project are given in "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques," Version 5.0: dated May 11, 1988, reprinted with corrections August 1, 1989. Specific project criteria and deviations from the general specifications are given in the following sections.

Project Network - A list (Table 1) and sketch of stations involved in this project will be provided.

Data Acquisition - Data collection must be accomplished as specified in the appropriate dual-frequency receiver field manuals in the compressed mode at a 15-second epoch collection interval. The GPS receivers must be dual-frequency and full-wavelength. Track satellites down to a 10-degree elevation angle.

The satellite observing scenario will be provided in Table 2. Sessions will generally begin at two observing windows at least 4 hours apart - 1400 UTC and 1830 UTC. The observing window will shift in weekly increments of 30 minutes instead of daily increments of 4 minutes. Vectors between the project stations shall be measured by single sessions consisting of continuously and simultaneously tracking for 5 1/2 hours.

Each FBN station must be occupied at least three times - twice at one observing window and once at the other. Each FBN station must be tied to two different bench marks. This bench mark tie requirement can be satisfied in one or two sessions. Adjacent FBN stations must be directly connected in at least one observing session, and at least one-half of all FBN base lines must be repeated. The CORS base lines will be repeated. CORS and CTCORS data will be used throughout the project.

For this project, each CBN station must also be occupied three times as described above. However, CBN stations can be tied to adjacent FBN stations (if the FBN station is closer than a CBN station), and a base line consisting of a CBN station and a FBN station can be used in the repeated-base line requirement mentioned above for the CBN portion of this project. The two bench mark tie requirement also applies to the CBN.

Record weather data just before, immediately after, and at the mid-point of each session. Meteorological data shall also be collected immediately after an obvious weather front passes during a session and immediately before it passes, if possible. Pressure and relative humidity measurements must be made near and at about the height of the GPS antenna phase center. Indicate in the log the location of the barometer and psychrometer.

Survey operations shall be conducted with due regard to the safety of personnel and equipment. Contact with the airport traffic control tower is mandatory during surveys at any controlled airports.

Vector Computations - Data management, quality review of collected data, and final vector processing for the FBN survey will be accomplished by the NGS project coordinator using PAGES. Vectors shall be computed in the International Earth Rotation Service Terrestrial Reference Frame (ITRF) system, using the most current epoch and precise IGS ephemerides. Use

30-second epoch intervals for data processing. Monument positions will be used for CORS when available, otherwise, antenna reference point (ARP) positions will be used. (Mr. Michael Morrison, N/NGS6, will be responsible for processing the Nebraska data.)

The data will be processed in 24-hour sessions (or slightly longer if the observation session crosses 0000 UTC) in order to utilize the 24-hour data sets collected at the CORS and CTCORS. The “fixed baseline” option in PAGES will be used to compute direct baselines between the CORS and CTCORS. The “fixed baseline” scheme will depend on the location and reliability of the CORS and CTCORS used in this project.

For stations where weather data are not available, or are suspect, predicted values computed based on the station's latitude, height above mean sea level, and time and day of year will be used. Use 15 degrees as the cutoff elevation angle in data processing. A cutoff angle of 10 degrees may be used when necessary to improve results.

The type of final solution, L1 versus ion-free, will depend on the length of the vectors. For vectors which are less than 10 km in length, the final reduction will consist of a L1 fixed solution. These vectors will be computed in a separate processing session from the longer vectors computed in an ion-free solution.

In general, vectors greater than 10 km in length are to be computed in an ion-free fixed, or partially-fixed, solution. In all cases, integer ambiguities will be fixed for each vector whenever possible.

The quality of collected data shall be determined from the plots generated from PAGES, by analysis of repeated vectors and/or comparison of station positions, and free adjustment residuals and/or loop misclosures. In addition, a constrained adjustment constraining all CORS will be performed.

The NGS project coordinator will perform all quality checks for conformance with NGS format standards such as executing software programs COMPGB, OBSCHK, and OBSDES. The final ITRF vectors will be assessed and transformed to the NAD 83 coordinate system using program ADJUST.

The data and results will be submitted to the Observation and Analysis Division. All B-files and G-files must be complete, including *25* and *27* records.

Station Descriptions - Station recovery notes must be submitted in computer-readable form using DDPROC software. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include the telephone numbers of private property owners.

Special Requirements - Antenna set-up is critical to the success of this project. Fixed-height tripods are preferred for all receivers. The plumbing bubbles on the antenna pole of the fixed-height tripod must be shaded when plumbing is performed. They must be shaded for 3 minutes before checking and/or re-plumbing. Also, the perpendicularity of the poles must be checked at the beginning of the project and any other time there is suspicion of a problem.

When a fixed-height tripod is not used, the height of the antenna must be carefully measured to prevent station set-up blunders from occurring. Tribrachs used for these set-ups must be checked and adjusted when necessary. Totally independent measurements of the antenna height above the mark in both metric and English units must be made before and after each session. Someone other than the observer must check the measurement computations by carefully comparing measurements and then entering his/her initials on the log.

Some GPS antennas have detachable ground planes and radomes. In order to help identify what exactly was used at a particular site, it would be useful to have a snapshot of the setup. All co-observers should take a photograph of the setup, if possible, with a close-up of the antenna as viewed from the side.

In addition, a rubbing of the stamping of the mark must be made at each visit to a station. If it is impossible to make a rubbing of the mark, a plan sketch of the mark must be substituted, accurately recording all markings.

Also, for each station visited, a visibility obstruction diagram must be prepared and the TO-REACH description carefully checked for errors or omissions.

Lastly, the following must be recorded at each occupation of a station:

(1) receiver manufacturer,
(2) antenna manufacturer,
(3) receiver model number (part number),
(4) antenna model number (part number),
(5) the complete serial number of the receiver, and
(6) the complete serial number of the antenna.

Success of this project requires that the highest quality GPS data be collected. Therefore, during each station occupation, the operators shall carefully monitor the operation of the receivers. Any irregularities in the data due to equipment malfunction, DOD adjustment of the satellite orbit, obstructions, etc., must be reported to the Field Operations Branch, N/NGS41, as soon as possible and noted on the observing log. If the quality of observations for an observing session is questionable, notify the Field Operations Branch immediately.

The survey team shall not depart the project area until they have quality reviewed all data, advised N/NGS21, and notified N/NGS41.

GPS DATA:

Visibility tables and plots of the present satellite constellation for May 17, 2000, have been reviewed and two observing windows selected. For operational use, current data must be generated with Trimble mission planning software or from program SATMAP.

Project report and data listed in Annex L of "Input Formats and Specifications of the NGS Data Base" and in the attached addendum for the adjustment portion must be transmitted. Any data considered suspect as to quality in achieving accuracy standards should be sent via FedEx immediately for office review. Backup of transmitted data must be held until notified by the Field Operations Branch, N/NGS41.

The data set collected during the project shall be named "nero050d.763". All records in connection with this project shall be titled “NEBRASKA FBN, 2000". The project number (accession number) is GPS-1481.

LIAISON:

Liaison must be maintained with designated offices at the National Geodetic Survey headquarters located at:

1315 East-West Highway
Silver Spring, Maryland 20910-3282

Questions and problems concerning survey field operations should be directed to:

William T. McLemore, Jr.
Chief, Field Operations Branch
Observation and Analysis Division
N/NGS41, SSMC III, Station 8564
Telephone: 301-713-3215, ext. 117
Fax: 301-713-4327
e-Mail: mclemore@ngs.noaa.gov

Questions and problems concerning adjustment processing should be directed to:

Maralyn L. Vorhauer
Observation and Analysis Division
N/NGS4, SSMC III, Station 8562
Telephone: 301-713-3176, ext. 104
Fax: 301-713-4327
e-Mail: maralyn@ngs.noaa.gov

Questions and problems concerning vector processing should be directed to:

Juliana Blackwell
Field Operations Branch
Observation and Analysis Division
N/NGS41, SSMC III, Station 8458
Telephone: 301-713-3215, ext. 108
Fax: 301-713-4327
e-Mail: Juliana.Blackwell@noaa.gov

Questions and problems concerning using CORS data in

processing should be directed to:

Neil Weston
Geosciences Research Division
N/NGS6, SSMC III, Station 9830
Telephone: 301-713-2847, ext. 202
Fax: 301-713-4475
e-Mail: nweston@ngs.noaa.gov

Questions and problems which could affect the technical adequacy of the project should be directed to:

Stephen J. Frakes (Douglas R. Hendrickson)
Chief, Project Development Branch
Spatial Reference System Division
N/NGS21, SSMC III, Station 8853
Telephone: 301-713-3194, ext. 111 (ext. 127)
Fax: 301-713-4316
e-Mail: steve@ngs.noaa.gov (dough@ngs.noaa.gov)

The NGS project coordinator is:

Michael Morrison
Geosciences Research Division
N/NGS6, SSMC III, Station 9843
Telephone: 301-713-2851, ext. 208
e-Mail: mikem@garth.grdl.noaa.gov

The coordinator for the CBN is:

Mr. Jerry Odum
Nebraska Department of Roads
1500 Highway 2, Room 10A
Lincoln, Nebraska 68502-5480
Telephone: 402-479-4379
Fax: 402-479-3729
e-Mail: jodum1963@aol.com

Other CBN contacts are:

Mr. Ken Hartwig
Nebraska Department of Roads
Roadway Design Division
1500 Highway 2
Lincoln, Nebraska 68502
Telephone: 402-479-4682
e-Mail: khartwig@dor.state.ne.us

Mr. Brian Dunnigan
Nebraska Natural Resources Commission
301 Centennial Mall South
Lincoln, Nebraska 68509-4876
Telephone: 402-471-3934
e-Mail: dunnigan@nrcdec.nrc.state.ne.us

Mr. Larry Worrell
Lancaster County Surveyor
444 Cherry Creek Road, Building C
Lincoln, Nebraska 68528
Telephone: 402-441-7681
e-Mail: lworrell@ci.lincoln.ne.us

Mr. Ron Way
Douglas County Surveyor
15505 West Maple Road
Omaha, Nebraska 68116-5173
Telephone: 402-444-6306
e-Mail: rway@co.douglas.ne.us

Mr. Tom Lynam
Sarpy County Surveyor
15100 S. 84th Street
Papillion, Nebraska 68128-4627
Telephone: 402-339-4604, ext. 109
e-Mail: lynamt@sarpy.com

The contact for obtaining data for the three Nebraska base stations is:

Mr. Steve Cobb
Nebraska State Surveyor’s Office
555 North Cotner Boulevard - LL
Lincoln, Nebraska 68505
Telephone: 402-471-2566
Fax: 402-471-3057
e-Mail: scobb@sso.state.ne.us

Names and telephone numbers of local contacts are given in the station description material.

ADDRESS:

Keep N/NGS41 informed of the party's post office, physical address, and telephone number at all times.

PUBLICITY:

See "NGS Operations Handbook," Section 1.4.1.

EXPENSES:

FBN expenses for this project will be charged to task number 8K6D2000.

TRAVEL:

Travel and per diem are authorized in accordance with Federal Travel Regulations, Part 301-11, Per Diem Allowances. Current per diem rates were effective January 1, 2000.

ACKNOWLEDGMENT:

Please acknowledge receipt of these instructions in your Monthly Report.

cc: N/NGS - D. Zilkoski*
N/NGS - S. Misenheimer*

N/NGS1 - G. Mitchell
N/NGS1x1 - J. Odum
N/NGS11 - S. Cofer
N/NGS21 - S. Frakes
N/NGS21 - R. Anderson
N/NGS21 - D. Hendrickson*
N/NGS22 - T. Soler
N/NGS3 - E. Allen
N/NGS4 - E. Wade
N/NGS4 - M. Vorhauer
N/NGS4 - D. Hoar
N/NGS41 - W. McLemore
N/NGS41 - J. Blackwell
N/NGS5 - R. Snay
N/NGS6 - M. Morrison
N/NGS6 - N. Weston
FGCS Members*
Ken Hartwig, Nebraska Department of Roads
Brian Dunnigan, Nebraska Natural Resources Commission
Larry Worrell, Lancaster County Surveyor
Ron Way, Douglas County Surveyor
Tom Lynam, Sarpy County Surveyor
Steve Cobb, Nebraska State Surveyor’s Office

* first page only

DATA TO BE SENT TO HEADQUARTERS RELATING TO THE ADJUSTMENT PORTION OF FBN/CBN PROJECTS

Free adjustment in NAD 83 (UNIX run).

Plots of the free adjustment created by running "plotres_prompt.bsh" on a UNIX server. Plots require a printer that supports postscript. The output file (long.out) contains a list of residuals which may be sorted using the following commands:

```
vi long.out
:1,$ !sort +0.47 (sorts horizontal residuals)
:1,$ !sort +0.71 (sorts vertical residuals)
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(OPTIONAL) Constrained horizontal adjustment holding NGS CORS positions and ellipsoid heights.

Final combined Blue Book file (ASCII required) with *86* records (GEOID99).

Final description file (ASCII required.)

Final G-file (ASCII required.)

OBSCHK output.*

CHKDDESC output.*

OBSDES output.*

*Any errors or warning messages must be explained.